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Original Research Article

Comparison of nerve block anesthesia and local infiltration anesthesia with lidocaine hydrochloride in primary root canal treatment of mandibular molars

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Abstract

Purpose: *To investigate and compare the analgesic effects of nerve block anesthesia and local infiltration anesthesia in one-visit root canal therapy of mandibular molars.*
Methods: *A total of 120 patients who underwent one-visit root canal therapy for mandibular molars were divided into nerve block group (n = 76) and local infiltration group (n = 44). Lidocaine was used to anesthetize the two groups. Perioperative heart rate (HR), diastolic blood pressure (DBP) and systolic blood pressure (SBP) were determined in the two groups. Visual analogue scale (VAS) and Ramsay sedation scale were used to assess postoperative pain and sedation in the two groups. The occurrence of adverse reactions was also compared.*
Results: *The success rate of the anesthesia in the nerve block group was significantly higher than that in local infiltration group (9 7.37 vs 88.64 %; p < 0.05). There were no significant differences in HR, DBP and SBP levels between the two groups. Over time, VAS and Ramsay scores decreased in both groups, while the VAS and Ramsay scores in the nerve block group were significantly lower than those in the local infiltration group (p < 0.05). The incidence of adverse reactions in the nerve block group was 5.26 %, which was not significantly different from 13.64 % incidence rate in local infiltration group (p > 0.05).*
Conclusion: *Both anesthesia methods have little effect on hemodynamics in patients undergoing one-visit root canal therapy for mandibular molars, but lidocaine nerve block anesthesia is more effective and has stronger analgesic and sedative effects than lidocaine local infiltration anesthesia.*

Keywords: *Nerve block anesthesia, Local infiltration anesthesia, Mandibular molars, One-visit root canal therapy, Analgesia, Lidocaine*

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INTRODUCTION

The one-visit root canal treatment of mandibular molars requires the surgeon to be familiar with the internal anatomy and morphology of the patient's root canal, which facilitates subsequent filling and avoids the risk of bacterial leakage, significantly shortening the patient's hospital stay

and reducing the time spent on multiple clinical operations. The one-visit root canal is now widely used in clinical practice and is well accepted by patients [1, 2]. Studies have shown that primary root canal treatment in the mandibular molar area is more effective than traditional methods of root canal treatment [3]. However, the anatomy of the mandibular molar region is very special, making the choice of anesthesia critical, which directly determines whether or not the treatment can be successfully completed [4].

Periodontal local infiltration anesthesia is the injection of an anesthetic into the patient's periodontal tissues, so that the function of the local nerve endings of the nociceptive conduction is reduced and thus, a safe and effective anesthetic effect is achieved. Administering it is simple, and it has a rapid onset of action [5]. However, injecting anesthetics makes it challenging for the operator to regulate the injection rate, which makes the patient's subjective pain more apparent. In addition, some anesthetics easily enter soft tissues and cause soft tissue injury. Nerve block anesthesia, on the other hand, is the injection of local anesthetics into the patient's nerve trunk and its surrounding branches to prevent the afferent input of related stimuli, resulting in anesthesia being in the blocked nerve distribution area [6].

Studies have shown that it is more demanding for the operator and is prone to complications such as local haematoma after injection [7]. However, there is no clinical consensus on the choice of the two types of anesthesia.

This study therefore compares the value of the two anesthetic modalities in primary root canal treatment of mandibular molars, with a view to providing an evidence-based guise for the choice of the best anesthetic modality in clinical practice.

METHODS

Patients

A total of 120 patients who underwent one-visit root canal therapy for mandibular molars in our hospital from June 2020 to June 2021 were retrospectively selected.

Inclusion criteria

(1): All patients underwent one-visit root canal therapy for mandibular molars; (2): Patients with American Society of Anesthesiologists (ASA) physical status I - II; (3): Patients aged > 18 years.

Exclusion criteria

(1): Patients who were allergic to the anesthetic drugs used in this study; (2): Patients who had communication and cognitive impairment; (3): patients who had important organ dysfunction; (4): patients who had chronic diseases.

Based on the different anesthesia methods, the patients were divided into nerve block group (n = 76) and local infiltration group (n = 44). In nerve block group, there were 34 males and 42 females, aged 2 4 ~ 45 years, with mean age of 34.56 ± 3.38 years. There were 46 patients with ASA I and 30 patients with ASA II. In local infiltration group, there were 21 males and 23 females, aged 24 - 45 years, with mean age of 34.79 ± 3.26 years. There were 27 patients with ASA I and 17 patients with ASA II. There was no significant difference in gender, age and A SA grade between the two groups (p > 0.05).

Ethical approval

This study complied with the basic requirements of the Declaration of Helsinki [8] and was approved by the ethics committee of Hebei Eye Hospital (approval no. 2020-06-682). Signed written informed consents were obtained from all participants before the study.

Treatments

The anesthetic drugs were prepared in the following manner: the Lidocaine Hydrochloride Injection comes in a package specification of 20 ml with 0.4 g in 5 vials. It is manufactured by Shanghai Zhaohui Pharmaceutical Co. Ltd. (Shanghai, China), with approval no. GYZZ H31021071.

Anesthesia was administered in both the nerve block and local infiltration groups. Patients opened their mouth and kept their mandibular plane parallel to the ground. The syringe was placed between the first and second premolars at an angle of 45°, and the injection needle was placed 1 cm above the mandibular surface at the intersection point between the midpoint line and between the maxillary and mandibular alveolar ridges, and 3 - 4 mm lateral to the pterygomandibular fold at a depth of about 2.5 cm. Lidocaine (2 mL) was injected at a rate of 1 ml/min after no blood was withdrawn. In the local infiltration group, the periodontal ligament was inserted into the buccal, distal buccal, juxta-lingual and distal lingual sites at a depth of about 0.5 cm, and 0.1 - 0.5 % lidocaine (0.5 mL) was injected into each site at a rate of 1 mL/min.

Patients in both groups underwent one-visit root canal therapy such as pulp opening, pulp extraction, root canal preparation and root canal filling 5 min after anesthesia, and the operation time was ≤ 1 h. All anesthesia was performed by the same senior physician.

Evaluation of parameters/outcomes

Effectiveness of anesthesia

The patients' subjective perception of pain and their facial expressions were evaluated to determine the effectiveness of the anesthesia [9]. Complete anesthesia is achieved when the patient experiences no pain, exhibits no painful expressions, and can successfully cooperate with the doctor to complete the treatment. Anesthesia is considered good when the patient experiences mild pain, exhibits no obvious painful expressions, cooperates well with the doctor, and can tolerate the treatment. Anesthesia is deemed effective when the patient experiences pain, exhibits obvious painful expressions, but can still tolerate and successfully complete the treatment. However, anesthesia is considered ineffective when the patient experiences obvious pain, exhibits painful expressions, the treatment cannot be successfully completed, and additional anesthetics are required during the treatment. Anesthesia success rate (ASR) was computed as shown in Eq 1.

ASR = CAR + GAR + EAR ……. (1)

where CAR, GAR and EAR are complete anesthesia, good anesthesia and effective anesthesia rates, respectively.

Hemodynamic indices

Heart rate (HR), diastolic blood pressure (DBP), and systolic blood pressure (SBP) were recorded before anesthesia (T_1), 5 min after anesthesia (T_2) and at the end of treatment (T_3)

Pain and sedation

Patients were assessed for pain and sedation using the Visual Analogue Scale (VAS) for pain [10] and Ramsay Sedation Scale [11] before anesthesia (T_1), 5 min after anesthesia (T_2), and at the end of treatment (T_3). On a VAS, a rating of 0 to 2 indicates slight pain, while 3 to 5 points indicate moderate pain. Severe pain is rated between 6 to 8 points, and a score of 8 to 10 points indicates extremely severe pain. The Ramsay sedation scale has a dysphoria rating of 1 point, while 2 to 5 points indicate reasonable sedation. Excessive sedation is rated as 6 points.

Incidence of adverse reactions

Patients were observed for adverse reactions during 24 h of anesthesia, including local edema, dizziness, palpitation, nausea, vomiting and allergic rash.

Statistical analysis

Data processing was performed using SPSS statistical analysis software (version 26.0) (IBM, Armonk, NY, USA) to meet the measurement data of HR, DBP, SBP, VAS, Ramsay, etc., with normal distribution and equal variance expressed as mean ± standard deviation (SD). Two-sample independent *t*- test was used to compare differences between the groups without time factors, while analysis of variance (ANOVA) was used to compare the differences between the groups with time factors. Enumeration data, such as adverse reactions and success rate of anesthesia, are expressed as {N (%)}; Chi square (χ^2) test was conducted and $p < 0.05$ was considered statistically significant.

RESULTS

Success rate of anesthesia

The success rate of anesthesia was significantly higher in the nerve block group than in the local infiltration group (97.37 *vs.* 88.64 %; $p < 0.05$), as shown in Table 1.

Comparison of hemodynamic characteristics between the two groups

At T_1, T_2 and T_3, there were no significant differences in HR, DBP and SBP levels between the two groups ($p > 0.05$), as shown in Table 2.

Pain and sedation scores

VAS and Ramsay scores decreased over time in both groups, but VAS and Ramsay scores in nerve block patients were significantly lower than that in local infiltration ($p < 0.05$; Table 3).

Adverse reactions

The incidence of adverse reactions in the nerve block group was 5.26 %, which was not significantly different from 13.64 % in the local infiltration group ($p > 0.05$); Table 4).

Table 1: Comparison of success rate of anesthesia between the two groups {n (%)}

Group	Complete	Good	Effective	Invalid	Anesthesia success rate
Nerve block (*n* = 76)	38 (50.00)	22 (28.95)	14 (18.42)	2 (2.63)	74 (97.37)
Local infiltration (*n* = 44)	17 (38.64)	12 (27.27)	10 (22.73)	5 (11.36)	39 (88.64)
χ^2					3.868
P-value					0.049

Table 2: Comparison of hemodynamic between the two groups (mean ± SD)

Group	HR (beats/min)			DBP (mm H g)		
	T_1	T_2	T_3	T_1	T_2	T_3
Nerve block (*n* = 76)	75.23 ± 8.90	84.63 ± 10.42	77.76 ± 8.96	73.38 ± 5.68	81.86 ± 9.21	74.17 ± 6.11
Local infiltration (*n* = 44)	75.49 ± 7.00	84.90 ± 8.67	75.77 ± 8.49	72.98 ± 5.50	84.34 ± 7.18	73.10 ± 5.50
F_{Time}/p	3.059/< 0.059			1.245/< 0.204		
$F_{Intergroup}/p$	2.147/0.067			0.789/0.376		
$F_{Time \times Group}/p$	0.320/0.727			1.720/0.181		

Group	SBP mm H g		
	T_1	T_2	T_3
Nerve block (*n* = 76)	118.09 ± 11.73	123.73 ± 14.16	116.26 ± 12.70
Local infiltration (*n* = 44)	117.49 ± 12.95	120.49 ± 13.16	115.34 ± 12.72
F_{Time}/p		1.730/0.191	
$F_{Intergroup}/p$		1.446/0.261	
$F_{Time \times Group}/p$		1.528/0.219	

Table 3: Comparison of pain and sedation scores between the two groups ($\bar{x}$±s, points)

Group	VAS			Ramsay		
	T_1	T_2	T_3	T_1	T_2	T_3
Nerve block (*n* = 76)	2.82 ± 0.59	1.25 ± 0.22	0.95 ± 0.25	2.79 ± 0.33	1.33 ± 0.35	1.04 ± 0.23
Local infiltration (*n* = 44)	2.76 ± 0.69	2.23 ± 0.50	1.37 ± 0.32	2.26 ± 0.35	1.87 ± 0.46	1.30 ± 0.40
F_{Time}/p		384.723/< 0.001			423.431/< 0.001	
$F_{Intergroup}/p$		15.513/< 0.001			5.838/0.017	
$F_{Time \times Group}/p$		38.382/< 0.001			68.017/< 0.001	

Table 4: Comparison of adverse reactions between the two groups [case (%)]

Group	Local oedema	Dizziness & palpitation	Nausea and vomiting	Allergic rash	Incidence of adverse reactions
Nerve block (*n* = 76)	1 (1.32)	2 (2.63)	1 (1.32)	1 (1.32)	4 (5.26)
Local infiltration (*n* = 44)	1 (2.27)	2 (4.55)	2 (4.55)	1 (2.27)	6 (13.64)
χ^2	-	-	-		2.558
P	-	-	-		0.110

DISCUSSION

Safe and effective anesthesia is essential for the successful completion of primary root canal treatment. However, the large number of root canals in the mandibular molar area and the difficulty in treatment makes anesthesia a relatively high requirement. In addition, the high cortical density of the alveolar bone and the presence of the external oblique ridge of the mandible, makes it difficult for the anesthetic to reach the appropriate bone surface, which may lead to anesthesia failure [12]. Therefore, the search for a more reasonable and effective anesthetic method and anesthetic drugs has now become a focus of clinical research.

Lidocaine is widely used in clinical anesthesia due to its strong permeability, wide diffusion and non-irritation of local tissues [13]. While both nerve block anesthesia and local infiltration anesthesia are the commonly used anesthesia methods in clinical practice, there are few comparative studies on the injection of lidocaine via these two anesthesia methods. Therefore, this study retrospectively analyzed cases of mandibular molars in order to evaluate the lidocaine analgesic effect in one-visit root canal therapy on mandibular molars.

Lidocaine is a local anesthetic that blocks the entry of sodium ions into nerve or heart cell membranes, thereby preventing information

transmission between cells and producing anesthesia. This anesthetic has several advantages, including good penetration, rapid onset, and a medium duration of action. [14]. The external oblique ridge divides the buccal bone surface of the mandible into upper and lower angulated surfaces, and when local infiltration anesthesia is performed, lidocaine is often injected into the upper plane of the external oblique ridge and the surrounding soft tissues without injecting it into the lower plane [15]. In addition, in the bolus injection of lidocaine, due to the uneven rate of bolus injection by the operator, the concentration of lidocaine varies across different sections of the mandible, resulting in insufficient anesthesia in some areas, which in turn induces anesthesia failure. Moreover, different bone densities in different parts of the mandibular cross-section, leads to a longer time for lidocaine to reach the corresponding nerve branches, resulting in reduced drug concentrations and resulting in anesthesia failure [16].

In this study, it was found that the success rate of anesthesia in the nerve block group was 97.37 %, which was significantly higher than the 88.64 % in the local infiltration group, suggesting that lidocaine nerve block showed a better anesthetic effect and ensured the smooth progress of one-visit root canal therapy. The reason for this may be due to the strong affinity of lidocaine to the nervous system in nerve block, which aids the blocking of the conduction of pain, and hence the nervous system is protected and rested. This reduces sensory and motor function in the area innervated by the nervous system, ultimately achieving the goal of anesthesia [17]. During the operation, the buccal fat pad tip with a size of 1 - 2 mm was used as the needle insertion point. Lidocaine was injected while pushing to reach the area where the inferior alveolar nerve entered the mandibular position, and the inferior alveolar, buccal, and lingual nerves were blocked and anesthetized to further block the conduction of pain sensation in order to achieve successful anesthesia.

In this study, VAS and Ramsay scores decreased over time in both groups, and VAS and Ramsay scores in the nerve block group patients were significantly lower than those in the local infiltration group, indicating that lidocaine nerve block has a more significant analgesic effect in one-visit root canal therapy of mandibular molars. The reason for this might be that the nerve block can spread lidocaine and then form a sagittal upward blocking impulse conduction pattern due to the bolus injection while inserting the needle during the operation. This can increase the coverage area of lidocaine on the cortical bone, resulting in a higher concentration of lidocaine passing through the bone. While anesthetizing the inferior alveolar nerve and its branches, the soft tissue mucosa such as the buccal gingiva is also anesthetized, so that the patient's pain is further reduced and a smooth operation is ensured [18]. However, during local infiltration anesthesia, the syringe produces greater fluid pressure and fluid flow rate when inserted into the periodontal ligament of the patient, and there are richer receptors in the periodontal ligament, which will produce significant pain when lidocaine is injected. In addition, the local infiltration effect of lidocaine is poor, and tissue penetration is not strong, which increases the patient's pain to some extent.

CONCLUSION

Lidocaine nerve block anesthesia has a higher success rate and stronger analgesic effect in one-visit root canal therapy of mandibular molars than lidocaine local infiltration anesthesia. However, limitations of this study is that the sample size used is small, and thus the results have selectivity bias and unity. The sample size should be expanded in further clinical trials for validation of the present findings.

DECLARATIONS

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Ethical approval

None provided.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflict of Interest

No conflict of interest associated with this work.

Contribution of Authors

The authors declare that this work was done by the authors named in this article and all liabilities

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